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November 14, 1997

Rosalee Chiara, Deputy Chief
Satellite Policy Branch
Satellite & Radiocommunication Division
International Bureau
Federal Communications Commission
2000 M Street, NW
Washington, D.C. 20554

Re: Terrestrial S-DARS Repeaters (Docket No. IB 95-91)

Dear Ms. Chiara:

This letter responds to a request from Commission staff to address specific issues regarding terrestrial repeaters. In particular, the staff has asked:

1. What is the estimated approximate number of terrestrial repeaters the CD Radio system will need?

2. Confirm that repeaters can be designed or configured to create "negligible" cross-border radiation in terms of interference potential.

3. What is the expected EIRP and antenna gain of a repeater?

As CD Radio has explained in its Comments and Replies in the above-captioned rulemaking, the FCC should permit blanket licensing of terrestrial repeaters used in connection with satellite DARS service, for several reasons:

- The allocation and the service itself already contemplate terrestrial stations transmitting within the authorized allocation; terrestrial repeaters normally will not exacerbate any adjacent channel interference and will ensure that consumers are not deprived of satellite DARS in difficult propagation environments.

- As CD Radio has long proposed, the terrestrial stations will be limited to repeating signals from the satellite. Thus, the terrestrial component of DARS is dependent on, and subordinate to, satellite transmissions. In particular, terrestrial stations cannot increase the service coverage area—it can only fill in weak or no-signal areas.

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- The Commission has eliminated individual licensing requirements for repeaters, boosters, and additional transmitters in a host of services—such as cellular, PCS, LMDS, and fixed microwave services—and has proposed to do the same for FM broadcast booster stations.

- Satellite DARS providers require the flexibility to respond to changing terrain and signal losses. For example, to provide reliable and high-quality service to the public CD Radio may need the ability promptly to install a repeater where new buildings have been constructed, creating blockage and shielding where there was no obstruction before.

- No purpose would be served by individual licensing. Market forces will assure that satellite DARS licensees will neither overbuild, nor underbuild terrestrial repeaters. An individual licensing requirement would result in a waste of the Commission's resources and unnecessary expense for licensees.

As a result, specific plans of satellite DARS licensees should not be of major relevance to the instant rulemaking. Indeed, given these facts, CD Radio suspects that opponents of blanket licensing—primarily terrestrial broadcasters without co- or adjacent-frequency licenses—seek DARS individual repeater licensing solely as a way of constraining satellite DARS flexibility and cost effectiveness.[1] Such a motivation—fear of marketplace competition—may be understandable, but should not persuade the FCC.

BACKGROUND

Solely for the information of the Commission staff, CD Radio herein provides a preliminary overview and estimate of its planned repeater operations. It is important to note, however, that this data may change:

- Detailed site engineering has not been completed; CD Radio is awaiting the FCC *Report and Order* so that it can comply with any regulatory requirements. Because CD Radio cannot move forward with terrestrial repeater engineering until the Commission defines the terms of licensing, CD Radio urgently requests the Commission to complete this rulemaking as quickly as possible.

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[1] The latest example of such opposition is a comment filed by Mt. Wilson FM Broadcasters, Inc., late-filed on October 24, 1997. This filing offers no new information and repeats policy arguments that at bottom object to the use of terrestrial repeaters because they will make the satellite-based service more attractive to consumers.

- The number of repeaters will vary as a function of repeater antenna installation height, transmitter power and antenna directivity, which cannot be finalized absent individual site surveys.

- The number of repeaters will vary as a function of repeater network type (*i.e.*, one-way versus cellular, active versus passive, etc.).

- The number of repeaters will vary as a function of topography (*i.e.*, San Francisco and Chicago will be different).

- The number of repeaters will vary as a function of local factors such as density and heights of obstructing buildings in urban cores, foliage, tunnels, etc.

With the foregoing in mind, what follows is general information about CD Radio's planned repeater design, and then specific answers to the staff's questions.

OVERVIEW

Considerable planning effort on the requirements for terrestrial repeaters has been accomplished, although detailed engineering has not been completed. Several important factors are summarized below:

- The transmission plan is based on CDMA PCS. The transmissions from the terrestrial repeaters are similar to those from the cell transmitters to the mobile users as specified by PCS standard I-95 and generally implemented in the United States at 1.9 GHz. The S-DARS mobile subscribers use a RAKE type receiver again similar to that standard.

- Although S-DARS has a cellular design heritage, S-DARS repeaters do not need to be as closely spaced as PCS cells. In PCS systems, a two-way transmission must occur between the repeater and the mobile unit. The size of a cell in a PCS system (and, thus, the number of transmitters required) is limited by the mobile unit's low-power transmitter, typically less than 0.5 watts. In contrast, the S-DARS terrestrial repeaters are transmitting a one-way signal to the mobile unit with significantly greater power (as discussed below). Thus the range between repeater and mobile is also much greater and S-DARS does not need as many repeaters as a PCS system to serve the same area.

- CD Radio will employ three types of S-DARS terrestrial repeaters:

  1. *Active.* The transmitter of this type repeater feeds, for various sites, a variety of directive antennas, which could include an omnidirectional "pancake," a sectorial coverage, or several sectorial coverages. The transmitter power of the various

repeaters varies with the type of antenna at a particular site, with the lowest power generally being associated with a single sectorial coverage. Also, the actual transmitter output power rating is higher than the power transmitted, to maintain quasi-linearity (*i.e.*, transmitter output power backoff). Given the differences in terrain, the actual transmitter powers can be expected to vary over a wide range.

2. *Passive.* This repeater consists of a directive receive antenna (*e.g.*, one meter diameter 23 dBi on-axis gain with 10° beamwidth) pointed at one CD Radio satellite that is connected to a low directivity transmit antenna (*e.g.*, 5 dBi patch). This passive repeater configuration is useful for filling-in "dead zones" in urban areas and unique topographies (*e.g.*, very steep mountain passes in the Rocky Mountains). The configuration is very inexpensive and generally provides low interference.

3. *Tunnels.* There are long tunnels in the United States, particularly in the eastern portion. The terrestrial repeater for this situation consists of a receiver located at the open area before such a tunnel which receives the signal and amplifies it with a low power (*e.g.*, 8 watt) transmitter. The transmitter is connected to a "leaky coaxial cable" usually installed in a tunnel ceiling cable run. The coaxial cable controlled leakage to vehicles in the tunnel is accomplished by a lengthwise split in the cable's shield.

RESPONSES TO SPECIFIC QUESTIONS

The Commission's inquiries are answered below in the context of the foregoing discussion.

Number of Repeaters

- The current plan for active terrestrial repeaters is to install them in forty major cities. A total of between 100-150 active terrestrial repeaters are believed required with higher numbers in the larger more dense cities (*e.g.*, the New York City area might require as many as ten whereas Tampa would require at most one repeater).[2] No significant numbers of active terrestrial repeaters are believed required in rural areas due to the use of satellite spatial and time diversity.

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[2] The number of required active terrestrial repeaters has been derived from several sources. One is the Canadian 1.5 GHz theoretical and demonstrational DAB terrestrial network adjusted for 2.3 GHz operation (see Francis Conway's paper in the *Proceedings* of the International Symposium on Digital Audio Broadcasting, Toronto, March 1994, describing a three site DAB

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- The active terrestrial repeater with the pancake omnidirectional antenna is expected to provide service within a 5-7 mile radius for a dense urban core when installed at 200-300 foot heights.

- Passive terrestrial repeaters will be used to fill in "dead zones" in urban areas, cover such zones in deep western highway passes, and assist in some dense foliage areas. Six to eight hundred of these are currently planned. Each passive receiver will cover approximately a 15 mile radius in "open" areas, assuming 70-100 foot height installation.

- Tunnel terrestrial repeaters will be installed in the major East Coast tunnels. Sixteen of them are planned.

Power and Antenna Gain

- The maximum transmitter useful output power is estimated at under one kilowatt. This represents the highest expected transmitter power; there will be many cases where the topography will permit significantly lower power levels. Antenna gains will vary for the same reasons, but would generally be between 15-28 dBi. Coverage in areas with multiple active terrestrial repeaters would generally be accomplished with sectorial beam antennas.

Cross-Border Interference:

- Interference coordination with Canada and Mexico will be required to consider both satellite and terrestrial repeater emissions. CD Radio expects that the interference criterion associated with the to-be-agreed satellite power flux density would be the basis for the terrestrial repeater criterion (with appropriate adjustment for elevation angle of arrival) throughout the adjacent administrations, other than in a few portions of the immediate border areas.

- There are a few cases near the border that will require special attention and detailed coordination. These are Seattle, Detroit, and Buffalo with Canada and

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transmitter network in Montreal with average site separation of 53 km). A second is 1.9 GHz CDMA PCS cell design, which CD Radio adjusted for one-way operation at 2.3 GHz (using Okumura and Hata). A third is the July 1996 CEMA 1.5 GHz DAB field test in San Francisco, where the entire downtown area received good service from two terrestrial transmission facilities using transmitter powers of under 100 watts.

San Diego and El Paso with Mexico. Any active terrestrial repeaters in these cities will be configured with sectorial antennas pointed to exhibit an approximately -15 dBi antenna gain at azimuths towards the border. This gain will be further reduced where required by artificial shielding (mesh screens with peripheral chokes). The screens can be configured to provide a further 15 to 25 dB of isolation depending on installation.

- The antennas of active terrestrial repeaters will generally be downward looking from the horizon which should make tropospheric and ionospheric scattering low, particularly due to the 2.3 GHz operating frequency. There is also no appreciable rain scattering at this operating frequency.

CONCLUSION

The previous technical discussion of required terrestrial facilities is based on CD Radio's design (now under construction) employing CDM with mobile receivers similar to PCS receivers using I-95 standard technology. In particular, the mobile receiver uses a 4 finger RAKE receiver and operates in an urban core area with a G/T of -22 dB/K. The RAKE receiver allows both constructive combining of significant strength multipath components and soft handoffs between the satellite and various types of terrestrial repeaters and between terrestrial repeaters themselves.

CD Radio has waited for seven years to obtain its licenses and has already paid auction fees of $83 million. Under these circumstances, CD Radio hopes that the Commission will expedite this final rulemaking proceeding and will adopt a policy of blanket licensing for terrestrial repeaters so that CD Radio can meet its goal of serving consumers by the Fall of 1999.

Please contact the undersigned if you require further information.

Respectfully submitted,

Robert D. Briskman /mz

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cc: Alexander Roytblat